	L #	Hits	Search Text	DBs	Time Stamp
1	L1	3983847	finger$4 or beam$4 or lead$4 or extens$4 or probe	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 15:49
2	L2	1118801	recess$4 or trench$4	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 15:49
3	L3	45695	L2 near4 L1	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 15:49
4	L4	112665	L1 near4 (cantilever$4 or expos$4)	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 15:49

	L #	Hits	Search Text	DBs	Time Stamp
5	L6	2983050	recess$4 or trench$4 or depression$4 or indent$6 or gap$4 or break$6	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 15:49
6	L7	28809	sacrificial	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 15:49
7	L8	321462	probe	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 15:49
8	L9	369934	probe$3	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 15:49

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9	L12	449	(438/584).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 15:49
10	L15	647	(438/597).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 15:49
11	L16	448	L15 and prob$6	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 16:01
12	L18	251	(438/620).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 15:49

	L #	Hits	Search Text	DBs	Time Stamp
13	L5	80	L3 same (etch$4 or remov$4) near4 L4	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 15:49
14	L10	12	L6 with L9 with L7	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 15:49
15	L11	86	L6 same L9 same L7	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 15:49
16	L19	3	L18 and lead$3 and probe$3	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 15:49

	L #	Hits	Search Text	DBs	Time Stamp
17	L13	169	L12 and lead$3	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 15:49
18	L14	125	L13 and prob$6	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 15:49
19	L17	175	L16 and lead$3	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 15:49
20	L20	119	17 and ((@ad<"20010323") or (@rlad<"20010323"))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 16:24

	L #	Hits	Search Text	DBs	Time Stamp
21	L21	8	20 and probe	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 16:01
22	L22	86	L6 same L9 same L7	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 16:14
23	L23	53	22 and ((@ad<"20010323") or (@rlad<"20010323"))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 16:24
24	L24	449	(438/584).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	2005/05/12 16:24

DOCUMENT-IDENTIFIER: US 20010039109 A1

TITLE: Lithographic contact elements

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Application Filing Date - APD (1):
20010205

Current US Classification, US Primary Class/Subclass - CCPR (1):
438/597

Continuity Related Application Date - RLFD (1):
20010205

Continuity Related Application Date - RLFD (2):
19981202

Summary of Invention Paragraph - BSTX (4):
[0003] Interconnection or contact elements may be used to connect devices or an electronic component or one electronic component to another electronic component. For example, a contact element may be used to connect two circuits of an integrated circuit chip or including an application specific integrated circuit (ASIC). Contact elements may also be used to connect the integrated circuit chip to a chip package suitable for mounting on a printed circuit board of a computer or other electronic device. Contact elements may further be used to connect the integrated circuit chip to a test device such as a **probe** card assembly or other printed circuit board (PCB) to test the chip.

Summary of Invention Paragraph - BSTX (6):
[0005] An example of a "relatively permanent" contact element is a wire bond. Once two electronic components are connected to one another by a bonding of a contact element to each electronic component, a process of unbonding must be used to separate the components. A wire bond contact element, such as between an integrated circuit chip or die and inner **leads** of a chip

or package
(or inner ends of **lead** frame fingers) typically utilizes a "relatively
permanent" contact element.

Summary of Invention Paragraph - BSTX (7):
[0006] One example of a "readily demountable" contact element is the contact
element between rigid pins or one electronic component received by resilient
socket elements of another electronic component. A second type of a "readily
demountable" contact element is a contact element that itself is resilient or
spring-like or mounted in or on a spring or resilient medium. An example of a
contact element is a tungsten needle of a **probe** card component. The contact
element of a **probe** card component is typically intended to effect a temporary
pressure connection between an electronic component to which the spring contact
element is mounted and terminals of a second electronic component, such as a
semiconductor device under test.

Summary of Invention Paragraph - BSTX (10):
[0009] In certain instances, spring contact elements themselves are not
resilient, but rather are supported by a resilient membrane. Membrane **probes**
exemplify this situation, where a plurality of microbumps are disposed on a
resilient membrane. Again, the technology required to manufacture such contact
elements limits the design choices for the shape and metallurgy of the contact
portion of the contact elements.

Summary of Invention Paragraph - BSTX (24):
[0022] The contact element of the invention is suitable for making either
temporary or permanent electrical connection between terminals of electronic
components such as a PCB and a chip under test. The contact element may be
fabricated as a permanent element directly on an electronic component, such as
a space transformer of a **probe** card assembly. Alternatively, the contact

element of the invention may be separately fabricated on a sacrificial substrate and affixed at its post end, for example, by soldering to on electronic component.

Detail Description Paragraph - DETX (3):

[0078] Suitable electronic components include, but are not limited to, an active semiconductor device, a memory chip, a portion of a semiconductor wafer, space transformer, a **probe** card, a chip carrier, and a socket. The electronic component may be an active device or a passive device that supports one or more electronic connections. Independent fabrication also avoids the exposure of the electronic component to the process conditions associated with forming the contact-element.

Detail Description Paragraph - DETX (5):

[0080] Disposed on an electronic component such as a space transformer of a **probe** card assembly, the contact elements of the invention are designed to accommodate contacts of terminals or electronic components having minimal pitch or spacing tolerances. The contact elements may also adopt alternating orientation (e.g., left-right-left-right) so as to achieve a greater pitch between their post portion than at the tip portion. In another embodiment, the contact elements may adopt alternating lengths (e.g., short-long-short-long) so as to achieve a greater pitch between the post portion than at the tip portion of adjacent contact elements. Similarly, alternating contact elements can be fabricated to have a greater pitch at their tip portions than their post portions. In summary, the contact elements, whether fabricated on or independent of the electronic component to which they are joined may adopt a variety of orientations to accommodate various configurations associated with the electronic components to which they contact.

Detail Description Paragraph - DETX (13):

[0088] Thus, based on the above relationship, controlling the thickness of beam portion 14 provides tight control of the spring constant. Controlling the spring constant for each contact element of an electronic component, such as the space transformer of a **probe** card assembly, allows a consistent contact force to be applied to each terminal, such a terminal 21 of a substrate under test (such as substrate 20).

Detail Description Paragraph - DETX (15):

[0090] FIG. 2 shows a cross-sectional side view of electronic component 100. Electronic component 100 is, for example, a space transformer of a **probe** card assembly or an integrated circuit. Electronic component 100 includes, for example, semiconductor- or ceramic-based substrate 105 having contacts or terminals 110 and 115 on opposing surfaces of substrate 105. In the case of a commercially available ceramic-based electronic component 100, for example, electronic component 100 contains terminals 110 and 115 on opposing surfaces of substrate 105. Terminals 110 and 115 are connected, for example, through conductive circuit 120 running through electronic component 100 such as, for example, a molybdenum or tungsten and molybdenum/tungsten circuit 120. Terminals 110 and 115 on substrate 105 are, for example, copper (Cu), nickel (Ni), and gold (Au) terminals that may be suitable for connecting to a contact element formed through the deposition of a conductive material by, for example, soldering. In one example, the copper facilitates the electroplating process and is the upper layer. The nickel acts as a barrier between the gold and the copper. FIG. 2 also shows shorting layer 117 on the underside surface of substrate 105. Shorting layer 117, such as for example, a titanium-tungsten (Ti-W) layer, serves, in this example, to short terminal 115 during the fabrication of contact elements on substrate 105. As will become

evident from
the description that follows, this shorting feature of shorting layer 117 can
advantageously be employed to establish an appropriate potential for an
electrolytic process (e.g., an electroplating process) for fabricating contact
elements on substrate 105. Shorting layer 117 may be removed, for example, by
a sputter or chemical etch process, once contact elements are formed on the
opposing surface of substrate 105.

Detail Description Paragraph - DETX (45):
[0120] The above description presented the first embodiment of the process
of the invention whereby a contact element is fabricated directly on an
electronic component such as a space transformer of a **probe** card assembly. A
particularly useful substrate for an electronic component is a ceramic-based
substrate. In one aspect of the invention, a ceramic-based electronic
component is chosen, for example, having terminals to accommodate corresponding
contact elements, formed by a process such as described, to test, for example,
multiple integrated circuit dice or chips at a time. Such an electronic
component can easily have 1500 or more contacts (terminals). As noted above,
the same method described to form a single contact element may be used to form
the additional contact elements.

Detail Description Paragraph - DETX (71):
[0146] FIG. 21(c) shows contact element 470 coupled to electronic component
480 such as the space transformer of a **probe** card assembly. Contact element
470 is coupled at its cost portion (of third conductive material 465) to a
terminal of electronic component 480 by, for example, soldering, brazing,
welding, conductive epoxy, tacking, or other technique.

Detail Description Paragraph - DETX (75):
[0150] FIG. 23 illustrates an application for an embodiment of the contact

element of the invention, specifically a resilient contact element or spring
contact element. In FIG. 23, contact elements 471 and 472 are affixed, for
example, in the manner described with respect to FIG. 13(c) or FIG. 22(b) to a
space transformer of **probe** card assembly so that tip portion ends 4711 and 4721
make pressure connections with terminals 492 of electronic component 490 such
as a semiconductor device, or an area of a semiconductor wafer (not shown)
containing a plurality of semiconductor devices.

Detail Description Paragraph - DETX (76):

[0151] FIG. 24 illustrates an application wherein a plurality of contact
elements 500 such as those described hereinabove are arranged on a substrate
such as a space transformer of a **probe** card assembly and affixed thereto in the
manner described hereinabove, so that their tip ends are disposed in a manner
suitable for making contact with the bond pad of a semiconductor device having
its terminals or bond pads arranged along its periphery. This application is
similar to he application described in co-pending, commonly-owned U.S. patent
application Ser. No. 08/802,054, titled "Microelectronic Contact Structure,
and Method of Making Same." In FIG. 24, each contact element 500 includes post
portion 502 and tip portion 504 and is mounted to an electronic component such
as a space transformer (schematically illustrated by the dashed line 510) of a
probe card assembly. Tip portion ends 504 are arranged in a pattern, mirroring
the pattern or bond pads 522 (illustrated schematically by circles) of an
electronic component (schematically illustrated by dashed line 520) such as a
semiconductor device. Contact elements 500 "fan-out" from their tip portions
504, so that each of their post portions 502 is disposed at a greater pitch
(spacing from one another) than their tip portions 504.

Detail Description Paragraph - DETX (77):

[0152] FIG. 25 illustrates another application (also similarly described in co-pending, commonly-owned U.S. patent application Ser. No. 08/802,054 wherein a plurality of contact elements 600 such as those described hereinabove are arranged on a substrate such as a space transformer of a **probe** card assembly and affixed thereto in the manner described hereinabove, so that their tip portions are disposed in a manner suitable for making contact with the bond pads or terminals of a semiconductor device having its bond pads or terminals arranged in a row along a center line thereof. In FIG. 25, each contact element, generally denoted by reference numeral 600, includes post portion 602 and tip portion 604, and are mounted to an electronic component such as a space transformer of a **probe** card assembly (schematically illustrated by dashed line 610). Tip portions 604 are arranged, in a pattern mirroring that of bond pad 622 (illustrated schematically by circles) of an electronic component (schematically illustrated by dashed line 620) such as a semiconductor device.
Contact elements 600 are arranged in the following sequence. A first contact element 600a is relatively short (e.g., has the length in an x-direction of approximately 60 mils), and is disposed to extend towards one side (right, as used) of electronic component 620. A second contact element 600b is adjacent first contact element 600a and is also relatively short (e.g., a length in an x-direction of approximately 60 mils), and is disposed to extend towards an opposite side (left, as used) of electronic component 620. Third contact element 600c is adjacent second contact element 600b and is relatively long (e.g., has a length in an x-direction or 80 mils), and is disposed to extend towards the one side (right, as used) of electronic component 620. Finally, fourth contact element 600d is adjacent third contact element 600c and is also relatively long (e.g., has a length in an x-direction of 80 mils),

and is
disposed to extend towards the opposite side (left, as used) of electronic
component 620. In this manner, tip portions 604 are disposed at a fine pitch
commensurate with that of bond pad 622, and post end 602 are disposed at a
significantly greater pitch from one another.

Detail Description Paragraph - DETX (81):
[0156] In this embodiment, using photolithographic techniques, the length of
the rectangularly-shaped beam portions 745A and 745B of adjacent contact
elements 740A an 740B may be varied. Adjacent contact elements 740A and 740B
are fabricated along the same axis (e.g., x-axis) at their post portions (post
portion 730A and 730B) and along a second axis (e.g., z-axis) at their tip
portions (tip portions 760A and 760B). As noted, beam portion 745A of contact
element 740A is patterned directly over post portion 730B of contact element
740B. Accordingly, in an x-direction, the post portions (730A and 730B) are
axially aligned. At the tip portion of each contact element (760A and 760B),
contact elements 740A and 740B are axially aligned along a y-axis. Thus, FIGS.
26(a) and 26(b) show adjacent contact elements that achieve a greater pitch
between their tip portions and their post portions. Such a configuration is
suitable, for example, to generate an electronic component with a plurality of
contact elements for **probing** a second electronic component having its bond pads
or terminals arranged along its periphery and having an ultra-fine pitch.

Detail Description Paragraph - DETX (83):
[0158] Adjacent contact elements 840A and 840B shown in FIGS. 27(a) and
27(b) are axially aligned in both their post portions and their tip portions.
Using photolithographic techniques, the rectangularly-shaped beam portion of
each contact element is fabricated to approximately the same length and the

resulting contact element is offset by the distance between the post portions
along the same axis. Such a configuration is suitable, for example, to
generate an electronic component with a plurality of contact elements for
probing a second electronic component having its bond pads or terminals
arranged in an ultra-fine pitch row along a center line thereof.

Detail Description Paragraph - DETX (85):

[0160] FIGS. 24-28(b) relate to layouts of electronic component utilizing a
contact element of the invention. It is to be appreciated, that the examples
described in FIGS. 24-28(b) are merely exemplary and that a plurality of other
configurations, including contact elements having more than two different
lengths disposed on a common component are contemplated. It is also to be
appreciated that the techniques illustrated in FIGS. 24-28(b) may be used to
generate an electronic component with a plurality of contact elements in any
arrangement required for **probing** of either peripheral or **lead**-on-center (LOC)
devices.